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DROSOPHILIDAE (DIPTERA) WITHIN THE ARCTIC CIRCLE II. THE EDINBURGH UNIVERSITY EXPEDITION TO SUB-ARCTIC NORWAY, 1953.

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(With 2 Plates and 7 figures in the text.)

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1. Introduction.

A great deal of work has been done in recent years on the *Drosophila* faunas of temperate and tropical areas but almost none on that of arctic regions. Therefore, when one of us (D. G. H.) was a member of the Edinburgh University Expedition to northern Norway in 1953, every opportunity was taken to collect Drosophilidae in order to learn something of the species that occurred there, at the northern fringe of their distribution. Basden (1956) gives a general survey of the present knowledge of " arctic " Drosophilidae.

2. The Collecting Areas.

A general account of the Edinburgh University Expedition to Norway is given in the official report (Anon, 1954), but further details bearing on the present work can usefully be given here.

The collecting was done near Furuflaten in Lyngsdal (69° 27′ N., 20° 10′ E), from 10th–27th July, 1953, and at Rosta in Rostadal (68° 58′ N., 19° 45′ E.), from 31st July to 22nd August, 1953, these places being 35 miles apart and respectively 200 miles and 165 miles north of the Arctic Circle (66° 32′ N.). Their general position is shown in figure 1.

The country is mostly very rugged, the mountains rising to 4000–6000 ft., with attendant ice caps and glaciers. Snow patches persist throughout the

FIG. 1.—General plan of the area in which Drosophilidae were collected. Heights in metres; dotted areas indicate woodlands. (Based on German military map.)

summer down to about 700 ft. Numerous streams and rivers drain the area and there are many lakes. The valleys are well wooded, the woods running in continuous belts joining valley to valley and broadening out considerably some 20–25 miles to the west of Rosta. The slopes of the mountains clearly show the vertical plant successions of mountainous arctic regions. Human habitations occur along the sea fjords and in clearings in the valley forests.

Furuflaten is a small village near the southern end of Lyngen Fjord and at the entrance to uninhabited Lyngsdal (Plate I, fig. 1), a steep-sided valley penetrating the Lyngen peninsula for about eight miles, with its upper three and a half miles containing glaciers. Drosophilidae were collected for about a mile along the valley and around the base camp (400 ft. above sea level) where turf was grazed by cattle and sheep amongst low *Juniperus communis*, *Calluna vulgaris* and *Vaccinium myrtillus* ; and with trees of *Alnus incana* and *Salix* bushes, especially near the river. The slopes bear mixed *Betula-Alnus* woods, the birch to a height of about 800 ft. above sea level, above which are heath and alpine vegetations.

Rosta (fig. 2) is approximately 400 ft. above sea level at the south-eastern end of Lille Rostavann, an inland lake, with the nearest sea 17 miles north and 40 miles west. It is a small settlement of some half-dozen farms (cattle, hay, rye, potatoes) in clearings in the birch forest (Plate II, fig. 4) at the easternmost limit of the farmed and settled area. Rostadal valley is thickly clothed with birch (*Betula* sp.) (Plate II, fig. 3), which here extends up the slopes to approximately 1200 ft., with willow and alder by the lake and along the river, and some areas of conifers. The vegetation along the valley bottom at Rosta is of a damp woodland type and is much more lush than at Furuflaten. At Lyngsdal alder was as common as birch, but at Rosta birch was the dominant tree, there being only a few alder. Most of the collecting at Rosta was done around the south-east corner of Lille Rostavann (fig. 2).

3. The Weather.

Before considering the Drosophilidae of the region some information is given on the climatic conditions with which they may have to contend. We have been supplied with meteorological records from the stations Skibotn and Dividalen (fig. 1), which give some idea of the conditions at Furuflaten and Rosta respectively. The average monthly temperature for each place is given in Table I.

Table I.—*Average temperatures* (°C).

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Year.
Skibotn													
1949–53 .	−5·2	−5·4	−3·0	1·7	4·8	10·8	12·3	12·2	8·1	3·9	−1·7	−3·4	2·9
1953 . .	−4·3	−8·2	−1·4	1·3	5·2	14·2	14·2	13·3	7·2	5·9	0·7	0·7	4·1
Dividalen													
1949–53 .	−8·7	−8·3	−5·5	0·4	3·7	10·8	12·1	11·8	6·8	2·0	−4·5	−6·7	1·2
1953 . .	−7·9	−11·4	−3·0	0·2	4·5	15·0	13·5	12·6	5·7	3·9	−1·7	−2·5	2·4

The average monthly temperature, T, is calculated by Köppen's formula : $T = n - k\,(n - \text{min})$, where n = average of the temperatures taken at 8, 13, and 19 hr. (Central European Time).

min = average of the minimum temperatures.

k = a factor appropriate for the station and the season.

ROSTA
MAIN TRAPPING SITES
0 Yards 200
Approx. scale
Approx. N
Farm
Farm
Farm
Birch & odd pine
Thinned birch, alder
Birch & willow
Willow
Shingle
Rostaelv
Hay
Oats
Potatoes
CAMPS
Birch forest
Approx. 200 yds. 70
Approx. ½ mile 42 43 69
Approx. ¾ mile 44 45
Approx. ¼ mile. Height 2,000 ft.
Approx. ¼ mile. Height 1,300 ft.
The following traps were situated at trees
I II III IV
28 31 34 37
29 32 35 38
30 33 36 39
52 55 58 61
53 56 59 62
54 57 60 63
74 75 76 77
78 81 84 87
79 82 85 88
80 83 86 89

Table I shows that it is colder at Dividalen than at Skibotn, except during June. At Dividalen the ground is usually snow-covered from mid-October to the beginning of May, whereas at the districts near the sea the snow may melt away several times. This latter state doubtless applies at Furuflaten and Skibotn, though the glaciers at the end of Lyngsdal would have some effect on the temperature of the former. The spring thaw of 1953 set in at the end of April at Lyngsdal and Rostadal, the subsequent flooding being about normal. The summer of 1953 was undoubtedly hotter and sunnier than usual.

The actual minimum and maximum temperatures recorded from September, 1952, to August, 1953, were :

	Minimum.	Maximum.
Skibotn . .	−20·5 °C. (5.ii.53)	27·0 °C. (20.vi.53)
Dividalen . .	−24·3 °C. (12.xii.52)	26·0 °C. (14.vi.53)

Precipitation at Skibotn during January to May, 1953, was much more than the last five-year average for this period (216 mm. compared with 130 mm.), but during June to August it was much less than the average (54 : 90 mm.) ; at Dividalen during the same periods the amounts were 124 : 94 mm. and 95 : 120 mm. The yearly average for Skibotn, 1949–53, was 333·8 mm.; for Dividalen 302·4 mm.

Leaf-opening in this part of Norway occurs in mid-May and leaf-fall at end September to beginning October, with some variation from year to year. Ripe soft fruits of 11 species were found during August, 1953. Autumn began in the mountains in mid-August, and leaves of trees in the valleys were changing colour at the end of August, 1953.

During the first five weeks of the collecting the light was bright enough to read by throughout the 24 hours.

4. The Collecting of Drosophilidae.

Flies were mostly collected by trapping, the traps of Basden (1954 : 604) being used. They were exposed from sea-level to 700 ft., with one at 1200 ft. and one at 2000 ft., and at different heights (0 to 40 ft.) from the ground. The trap-baits were apple (in 57 traps, 2 open baits), fig (24 traps), raisin (3 traps), these fruits mixed (3 traps), honey (8 traps), molasses (2 traps), whortleberry (2 traps), crowberry (1 trap), and juniper berry (1 trap). All except the last three were taken by the Expedition from Scotland. The apples (apple rings), figs and raisins were dried fruit and were soaked or boiled in water before use, and most of the baits were inoculated with live yeast to increase fermentation. The whortleberries (*Vaccinium uliginosum*), crowberries (*Empetrum nigrum*) and juniper berries (*Juniperus communis*) were collected and used at Furuflaten, being only bruised before use. All traps were left out for six or seven days.

The different habitats sampled were buildings (10 traps), various types of woods and bushes (90 traps), and open heath at or above the tree-line (3 traps).

Twenty-seven traps and one open bait (Nos. 1–27a) were exposed 0–18 ft. from the ground at Furuflaten ; and 74 traps, one open bait (Nos. 28–101, 106), 0–40 ft. from the ground at Rosta ; a total of 101 traps and two baits. The Rosta trapping sites are shown in figure 2. Drosophilids were caught in 14 traps, one open bait at Furuflaten, and in 61 traps, one open bait at Rosta. The flies

were preserved dry in paper squares or in spirit in plastic vials. No trap-baits were kept for the possible development of progeny, but an attempt was made, unsuccessfully, to bring live adults back to Scotland for breeding.

Some small scale net-sweeping of herbage at both places caught only three specimens (*D. obscura*, *D. funebris*, *Chy. costata*) at Rosta. None was seen at the few toadstools examined. Some leaves of *Stellaria media* at Furuflaten containing larval mines were kept in case it proved to be *Scaptomyza*, but subsequent examination showed no insects present. No bleeding trees the sap of which might attract drosophilids were noticed. During the last six days of the Expedition, D. G. H. concentrated on catching large numbers of flies, and therefore used what was thought to be the most productive bait (fig) in the most productive habitat (10 ft. high in birch woods).

Basden (1953*a*, and unpublished) has found in Scotland that more Drosophilidae were trapped higher in trees than lower down or on the ground. Harnden investigated this in the arctic by carrying out a detailed experiment on an "island" (fig. 2) in the river at Rosta (subsequently referred to as the *Island, island traps*, etc.). The results are discussed on p. 154.

5. Results of the Collecting.

(*a*) *General.*

A total of 2069 specimens of Drosophilidae was obtained, representing nine known and one unidentified species (Table II).

At Furuflaten a smaller proportion (54 per cent.) of traps was productive than at Rosta (82 per cent.) and the number of flies in the productive traps was lower, being 5·3 a trap at Furuflaten and 32 a trap at Rosta. One productive bait (fig) was not used at Furuflaten. Of the species that occurred in at least fair numbers, only *Am. alboguttata* was more plentiful at Furuflaten than at Rosta. Further than this the results at Furuflaten and at Rosta (Table II) cannot well be compared, as the trapping was done at different periods, and in the short arctic summer a difference of a week might affect the numbers.

The number of specimens obtained by trapping shows that the Drosophilid population in the wooded areas of sub-arctic Norway is quite rich in specimens of a few species, the commonest one by far being *D. obscura*. Such large numbers of this family have not previously been obtained in the arctic, doubtless because fermenting baits had not been employed.

Of the three main types of habitats sampled (woodland, open heath and buildings), woodland was very productive of species and specimens, but the two others produced little or nothing. The buildings (a temporary turf hut, dairy

Table II.—*Drosophilidae from Sub-arctic Norway*, 1953.

Locality.	*Drosophila obscura.*			**D. bifasciata.*		**D. silvestris.*		*D funebris.*			*D. littoralis.*	*D. transversa.*		*Chymomyza costata.*			**Amiota alboguttata.*		**Cacoxenus argyreator.*	*Drosophila* spp.	tal
	♂	♀	? sex	♂	♀	♂	♀	♂	♀	? sex		♂	♀	♂	♀	? sex	♂	♀			
Furuflaten	19	21	.	.	.	1	.	12	4	.	.	1	1	1	1	.	10	8	1♀	.	80
Rosta	926	865	10	29	38	.	1	31	14	1	1♀	1	3	21	27	2	5	9	.	5	989
Total	1841			67		2		62			1	6		52			32		1	5	069

* Not previously recorded north of Arctic Circle.
Drosophila spp. includes the unidentified species and 4 specimens indet. of the *obscura* group.

lean-to, cowshed, house food store, privy, and hay loft in barn) gave a total catch of only 3 *D. obscura*, 14 *D. funebris*, and 1 *D. transversa*. Duffield (1937) found no Drosophilidae in various buildings in similar areas of northern Norway during July and August. The open, elevated heath areas were not adequately sampled but the indications are that they were barren of Drosophilidae as the three traps caught none.

The most successful of the different substances used as baits were apple and fig, and the failures were honey and molasses. Apple attracted four more species than did fig, though only in single specimens, viz. *Cac. argyreator* at Furuflaten, and *D. littoralis*, *D. silvestris* and *D.* sp. at Rosta. It would appear that fig (1520 specimens in 24 traps) was much superior to apple (532 specimens in 59 traps) for number of specimens, but this may not be true, as during the most productive period (10th–22nd August) there was little direct competition between them, all the apple traps being confined to the Island, which was not such a rich area, and the fig traps mostly a distance from there. The other baits (see p. 151) caught only 12 specimens. Three other specimens were taken by sweeping and two more had no data.

(*b*) *Population increase.*

During the last six days of the Expedition at Rosta an attempt was made to collect the maximum number of specimens rather than sample different habitats. During these six days the most specimens of *D. obscura* (1240), *D. bifasciata* (50) and, to a less degree, of *Am. alboguttata* (12) were trapped (excluding those in the island traps out at about the same time), but this was due to a sudden increase in numbers, particularly of *D. obscura*.

This increase started on about 16th August 1953. For example, 14 traps exposed from 10th–16th August at various heights caught 109 specimens, 84 (77%) being *D. obscura*. In 12 traps exposed from 16th–22nd August at 10 ft., there were 1329 specimens, of which 1240 (93·3 per cent) were *D. obscura*. A contemporary rise in numbers is also shown for the island traps (Table III).

The increase in population, in some ways resembling the autumn flush in Scotland (Basden, 1953*b*), could have been a mass emergence caused by an increase in temperature. During 1st–12th August the minimum temperature, in an unheated hut, stayed fairly steady at 51°–57° F., and the maximum at 58°–65° F. During 13th–20th August the minimum was 60°–67° F. and the maximum rose from 66°–68° F. on 13th–14th August to a constant 72°–73° F. for the next six days.

Frey (1950) observed at Utsjoki, north Finland (lat. 69° 47′ N.), a mass appearance of Diptera and micro-Hymenoptera during warm days at the end of June and beginning of July, after an unusually cold, delayed summer. On Bear Island (lat. 74° N.) Lack and Bertram (Roman and Lack, 1934 : 204) noticed two species of Ichneumonidae and *Limnophora* sp. (Diptera : Anthomyidae) emerging in swarms from hide-outs in a patch of *Salix polaris* when the temperature rose above 6° C.

Another factor noticed by D. G. H., and which might have aided the spread of bait-smell or of flies, was an increase of wind force during this period. The numbers caught during the population increase were much the highest in those traps towards the west (Nos. 90–93), and this might have been due to wind

direction. No factors other than temperature and wind that could have had an influence on the numbers were noticed at the time.

As no rearing from the trap-baits or from any likely natural foods (toadstools, saps) was attempted, it is not known for certain whether any of the species bred in the sub-arctic. Some specimens of *D. obscura* and of *D. bifasciata* were pale-bodied, suggesting that they had recently emerged, these being first observed in traps exposed from 10th–16th August, at the start of the population increase. This part of Norway is intersected by strips of woodland along the valleys (fig. 1), and these valleys doubtless serve as dispersal or migration routes for *Drosophila* and other insects, perhaps to or from distant parts.

(*c*) *Vertical distribution of Drosophilidae.*

A wide enough range of ground-heights above sea-level was not sampled to allow a discussion on the limits of this type of vertical (altitudinal) distribution (which we propose to call *contour distribution*). At Furuflaten traps were out from sea-level to approximately 650 ft. ; at Rosta from 400–650 ft., with one at 1200 ft. and one at 2000 ft. The contour distribution (heights above sea-level) of the various species was as follows : *D. obscura*, 0–1200 ft. ; *D. bifasciata*, 400–500 ft.; *D. silvestris*, 400 ft.; *D. funebris*, 400–500 ft. ; *D. littoralis*, 400 ft.; *D. transversa*, 400 ft. ; *Ch. costata*, 0–400 ft.; *A. alboguttata*, 0–500 ft.; *Cac. argyreator*, 650 ft.; *Drosophila* sp., 400 ft. All were caught within or on the edge of the tree zones. Only one trap (fig, 10th–16th August) was exposed above the tree limits, at 2000 ft. amongst dwarf willow and dwarf birch in the fjaeldmark, but this caught no flies.

The distribution of Drosophilidae above the ground, *i.e.* true vertical distribution (which is usefully distinguished as *layer distribution*), was investigated fairly intensively on the Island at Rosta.

The Island is an area of approximately four acres between the main river and a southern subsidiary loop (fig. 2). Its eastern part is bare shingle, elsewhere there are willows by the waterside, but the main part bears large birch and alder trees rather thinly spaced, with grass below. Four trees were chosen, two alder (Nos. I, III) and two birch (Nos. II, IV), and traps of fermenting apple were put in each at heights of 10 ft., 20 ft. and 30 ft. The first lot of traps was out from 31st July–7th August, and the second and third lots from 7th–14th August and 14th–21st August respectively. Unfortunately no corresponding traps were placed at the bases of the trees, but other results showed that many fewer flies were to be caught on or near the ground at Rosta.

The results of the trapping are given in Table III. These show that traps at 10 ft. attracted most specimens (322 out of 438) of all but one species, traps at 20 ft. caught 69, and at 30 ft. caught 47 ; 30 ft. was the next best height when flies were scarcer, but when flies were plentiful more went to traps at 20 ft. than at 30 ft. The one species not taken at 10 ft. was *Am. alboguttata*, two specimens at 30 ft., but elsewhere at Rosta this species was found in six traps at 10 ft., and lower than this at Furuflaten.

It would appear, therefore, that in north Norway the flies preferred a lower situation in trees than they did in Scotland, where, in a somewhat similar woodland (of oak), they were most frequent in the upper part ; although one strip of half-mature beech produced most flies at ground level (Basden, 1953*a* and in preparation).

It can be gathered from Table III that trees varied in attractiveness. Throughout the whole period the order of attractiveness for number of specimens was Tree I first (207 flies), with IV (132), II (59), and III (40 flies), in descending order. Trees I and IV were on the S.E. edge of the island, whereas II and III were on the northern fringe of the trapping area and close to the main river (fig. 2). Otherwise there was nothing in the local conditions or in the trees themselves that suggested the reason for the differences. Tree I appeared to be preferred consistently by *Ch. costata* (20 out of total 31), but *D. obscura* did not show a preference for Tree I until the last week.

TABLE III.—*Layer distribution on the Island, Rosta.*

	Tree.	Trap No.	*D. obscura.* ♂	*D. obscura.* ♀	*D. obscura.* ? sex.	*D. obscura.* Total.	*D. bifasc.* ♂	*D. bifasc.* ♀	*D. silves.*	*D. funeb.* ♂	*D. funeb.* ♀	*Chy. costata.* ♂	*Chy. costata.* ♀	*Am. albog.*	*Droso-phila* sp.	Total speci-mens.	
31st July–7th Aug.																	
10 ft.	I	28	1	5	.		.	.	.	.	.	1	3	.	.	10	
	II	31	2	1	.	20	.	.	.	.	.	1	1	.	.	5	30
	III	34	.	4	.		.	.	.	.	.	1	1	.	1♂	7	
	IV	37	2	5	.		.	.	.	1	.	.	.	.	.	8	
20 ft.	I	29	1	.	.		.	.	.	.	.	1	2	.	.	4	
	II	32	1	.	.	7	.	.	.	.	.	.	.	.	.	1	10
	III	35	1	1	.		.	.	.	.	.	.	.	.	.	2	
	IV	38	2	1	.		.	.	.	.	.	.	.	.	.	3	
30 ft.	I	30	3	1	.		.	.	.	.	.	.	.	.	.	4	
	II	33	1	2	.	12	.	.	.	.	.	.	.	1♂	.	4	13
	III	36	.	.	.		.	.	.	.	.	.	.	.	.	Nil	
	IV	39	1	4	.		.	.	.	.	.	.	.	.	.	5	
7th–14th Aug.																	
10 ft.	I	52	.	1	.		.	.	.	.	.	1	4	.	.	6	
	II	55	1	2	.	12	.	.	.	1	.	1	1	.	.	6	24
	III	58	.	.	.		.	.	.	.	.	.	.	.	.	Nil	
	IV	61	4	4	.		.	2	1♀	.	.	1	.	.	.	12	
20 ft.	I	53	.	.	.		.	.	.	.	.	.	1	.	.	Nil	
	II	56	.	.	.	4	.	.	.	.	.	.	.	.	.	1	5
	III	59	1	1	.		.	.	.	.	.	.	.	.	.	2	
	IV	62	.	2	.		.	.	.	.	.	.	.	.	.	2	
30 ft.	I	54	3	6	.		.	.	.	.	.	.	.	.	.	9	
	II	57	1	1	.	12	.	.	.	.	.	.	1	.	.	2	13
	III	60	.	.	.		.	.	.	.	.	.	.	.	.	1	
	IV	63	1	.	.		.	.	.	.	.	.	.	.	.	1	
14th–21st Aug.																	
10 ft.	I	78	60	66	4		1	2	.	1	1	4	1	.	.	140	
	II	81	13	20	.	249	.	.	.	1	.	.	.	.	.	34	268
	III	84	1	9	.		.	.	.	.	.	.	.	.	.	10	
	IV	87	36	40	.		2	4	.	.	1	.	1	.	.	84	
20 ft.	I	79	6	13	.		.	.	.	.	.	1	2	.	.	22	
	II	82	3	2	.	49	.	.	.	.	.	.	1	.	.	6	54
	III	85	6	8	.		.	1	.	.	.	.	.	.	.	15	
	IV	88	7	4	.		.	.	.	.	.	.	.	.	.	11	
30 ft.	I	80	4	7	.		.	.	.	.	.	.	.	1♂	.	12	
	II	83	.	.	.	19	.	.	.	.	.	.	.	.	.	Nil	21
	III	86	1	2	.		.	.	.	.	.	.	.	.	.	3	
	IV	89	2	3	.		.	1	.	.	.	.	.	.	.	6	
Totals			165	215 (384)	4		3	10	1♀	4	2	12	19	2♂	1♂	438	

6. NOTES ON THE SPECIES OBTAINED.

Four of the species have not previously been recorded north of the Arctic Circle, these being *D. bifasciata*, *D. silvestris*, *Am. alboguttata*, and *Cac. argyreator*. All the nine named species are known from other parts of Europe and three of them are recorded from outside the Palaearctic region—*D. funebris* being

cosmopolitan, *D. transversa* occurring in China (Oriental) and eastern North America (Nearctic), and *Am. alboguttata* being recorded from North America. It has not yet been proved, however, that the European and other *D. transversa* or *Am. alboguttata* are conspecific (Basden, 1956). The *obscura* group, the dominant native group in Europe, is represented in subarctic Norway by *D. obscura*, *D. bifasciata* and *D. silvestris*.

Complete and clear drawings of the male genitalia, the most reliable character for identification, of these three closely-related species have not been published. The opportunity has therefore been taken of figuring them here, as well as that of the unknown species of *Drosophila*.

(1) *Drosophila obscura* Fallén (= *obscuroides* Pomini).

This is obviously the dominant species during July and August in northern Norway, the 1841 specimens comprising 89 per cent. of the total flies caught (Table III). It was taken in 74 of the 77 successful traps and baits, the highest number from one trap (No. 91, fig, 16th–22nd August) being 322 (185 males, 136 females, 1 ? sex). *D. obscura* occurred up to the fringes of the birch zone at Rosta (approx. 1200 ft.), no other species being taken as high as this, but it was most plentiful in the lower woods and clumps of trees. It was trapped at all heights in trees (up to 40 ft.). This keeping to trees and bushes and a general avoidance of buildings has been noticed in Scotland (Basden, 1954 : 627). Some pale specimens, as though recently emerged, were first observed in traps exposed from 10th–22nd August. There was a sudden increase in numbers of this species after mid August (see p. 153). *D. obscura* is widely distributed in Europe but had not been found so far north in Norway. Hackman (1954) records it from north Finland. Details of the male genitalia are shown in figure 3.

(2) *D. bifasciata* Pomini.

This species is recorded from Europe (Italy to Holland) and Japan, but has not yet been found in Britain. Its occurrence at Rosta was unexpected and this is its first record from north Europe. The 67 specimens were present in 18 traps (fig, apple) placed 0–30 ft. from the ground in birch and alder woodland. Two females in two traps (14th–21st August) were pale bodied, as though recently emerged. As has been noticed elsewhere in Europe, this species occurred mostly in small numbers, the largest number in one trap (No. 91) being seven males and ten females.

The male is easily distinguished from that of *D. obscura* by the genitalia, especially by the shape of the penial lancet processes (Basden, 1954 : 619, footnote ; figure 4 of present paper), otherwise the two species would be difficult to separate confidently. In the female the presence or absence of lateral yellow spots on the tergites of the abdomen is a useful character, but not wholly reliable. They are typically present in *D. obscura*, but are occasionally absent (proved by raising the progeny from unmarked Scottish examples—Basden, *unpublished*). In *D. bifasciata* there are usually no yellow abdominal marks, but in one Japanese strain (Hokkaido) seen by E. B. B. they are pronounced. The rather shorter spines on the ovipositor guide (see Burla, 1951, fig. 17b) will help to decide the identity in most females.

(3) *D. silvestris* Basden.

One male and one female of this species were obtained : the male, Furuflaten (raisin trap, 3 ft. above ground on edge of alder wood) ; the female, Rosta, (apple trap, 10 ft. in birch tree on the Island) ; both at 400 ft. above sea level. The species has a wide distribution in Europe (Sweden to Switzerland), but it had not previously been found in Norway. The male genitalia are shown in figure 5.

(4) *D. funebris* (Fabricius).

Sixty-one specimens of this cosmopolitan species were obtained at 18 traps, one open bait, and one specimen was swept from low herbage. Fourteen (10 males, 4 females) were at apple in a turf hut at Furuflaten, the remainder being taken outdoors at fig and apple placed 3 to 10 ft. high in various trees and bushes. It was not attracted to traps above 10 ft. Although it was not caught inside other buildings at Furuflaten and Rosta in which it might be expected (dairy, cowshed, privy, food store, and hay loft), it occurred most abundantly in the two traps at Rosta near a cow-goat shed (No. 68, 9 males, 2 females ; No. 96, 9 males, 5 females.) *D. funebris* is particularly attracted to animal quarters (Basden, 1954 : 635).

(5) *D. littoralis* Meigen.

One female, Rosta (trap No. 51, apple, 4 ft. high in willow by the river, 3rd–9th August). The habitat is the kind of damp situation expected for this species. Frey (1932) recorded it, as *D. lugubrina* Duda, from Lepidoptera bait (" Schmetterlingsköder ") in southern Finland ; and Duda (1935 : 88) from Mörsil and Gellivara (Sweden) and Uleaborg (= Oulu) (Finland). The species is scattered all over Europe, but this is the first record from Norway.

In this arctic specimen the stronger costal fringe extends only two-fifths the distance between the ends of the second and third veins instead of more than half-way as usual.

(6) *D. transversa* Fallén.

Six specimens in two traps (fig, apple) and at two open baits (apple), one of the latter being inside the turf hut. In the arctic, as in Scotland, it was taken only low down, the highest trap being 5 ft. from the ground. It is a common northern species (e.g. Hackman, 1954) but is met with all over Europe ; the same, or a very similar species, occurs in North America, Japan, and China.

(7) *Chymomyza costata* (Zetterstedt).

With 51 specimens in 22 traps and 1 male swept from low herbage, this species proved to be quite plentiful, especially at Rosta (Table II). The traps (15 apple, 7 fig) were at 2 to 30 ft. in willow, alder, and birch, with one in a pile of cut birch logs. The species was caught most frequently on the Island at Rosta (12 males, 19 females in 13 traps), but the largest number in one trap (6 males, 2 females) was near the cow-goat shed (No. 68). Basden (1954 : 650) recorded two females near a cow byre and in a fruit store in Scotland, but there

FIG. 3.—*Drosophila obscura* Fallén. Male genitalia, side view. (Furuflaten.) Note the bifid penis, the broad-ended lancet process, and the short hypandrium.

FIG. 4.—*D. bifasciata* Pomini. Male genitalia, side view. (Rosta.) The pincer (paired) (*a*) is drawn somewhat foreshortened, if flat it

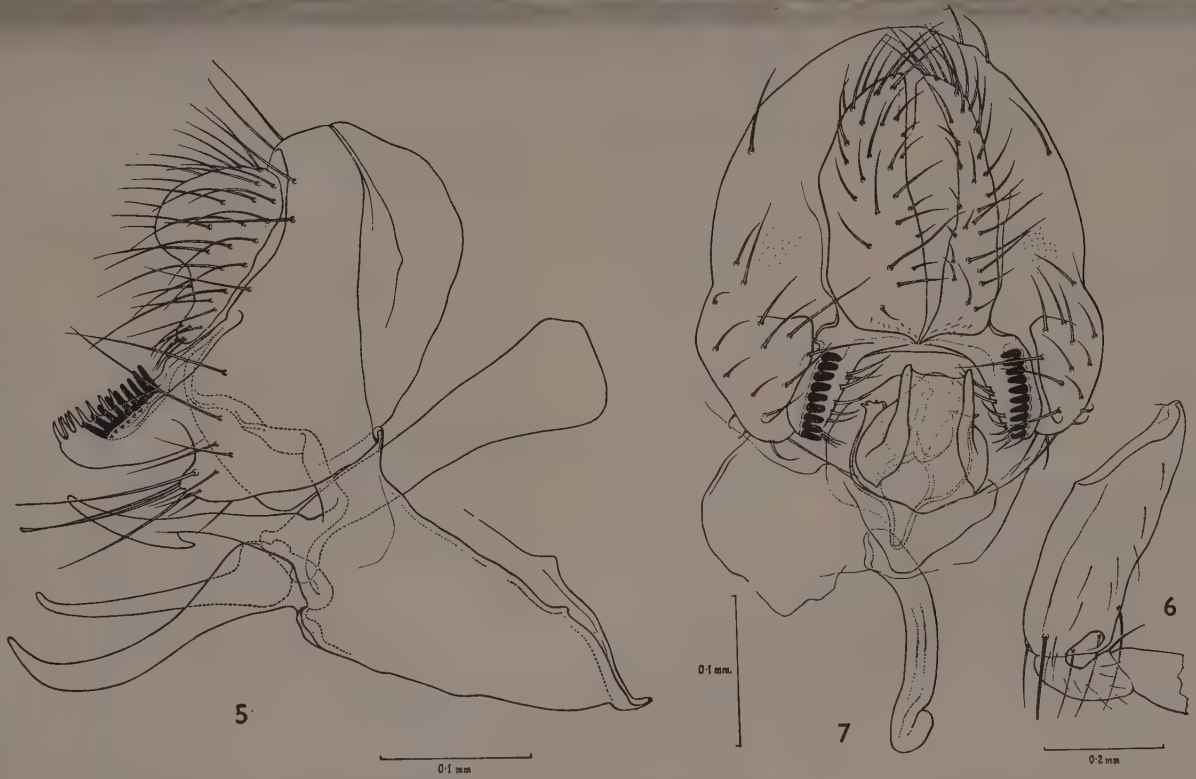

FIG. 5.—*D. silvestris* Basden. Male genitalia, side view. From paratype specimen. (Liberton, Edinburgh, Scotland.) Note " barbed " pincer.

FIGS. 6—7.—*Drosophila* sp. (Rosta.) (6) First coxa, showing characteristic spine at end. (7) Male genitalia, face view.

it was very rare at fruit baits. It appears to be a common northern species but is found at least as far south as Hungary.

(8) *Amiota alboguttata* (Wahlberg).

The 32 specimens were taken in 15 traps (7 apple, 6 fig, 1 whortleberry, 1 raisin) placed 3–30 ft. above the ground amongst willow, birch and alder. Frey (1932) captured it on unspecified Lepidoptera bait at Tvärminne, south-west Finland, but it extends south to Germany at least, and it is supposed to occur in North America. All the arctic specimens have pale yellow legs, agreeing with Scottish specimens from Kinrara and Glen Feshie (Spey Valley) taken by J. E. Collin, whereas those from the Edinburgh district of Scotland (E. B. Basden) have darkened legs.

The present specimens represent the most northerly record for the species, as well as a new species to the Norwegian list.

(9) *Cacoxenus argyreator* Frey.

One female, Furuflaten, (apple trap, 11th–18th July, near the ground in alder thicket, 650 ft.) in the gulley of a small stream. Frey (1932) originally found this species in considerable numbers on Lepidoptera bait in southwest Finland at Tvärminne, but for only a short period, 25th June–7th July, 1932 ; three other specimens were taken at Lojo on aspen stamens (catkins), 22nd–30th June, 1932. The above female appears to be the first specimen known outside southern Finland.

(10) *Drosophila* sp.

One male specimen of a *Drosophila*, which we do not recognise, was taken in an apple trap (No. 34, 31st July–7th August) on the Island at Rosta, at a height of 10 ft. in an alder (Tree III). The specimen was somewhat damaged, but it is a brownish species almost 2 mm. long and with six to eight irregular rows of acrostichal hairs on the thorax. Its main characteristic is a strong straight *blunt* spine at the posterior end of the first coxa on the outside, at the junction with the trochanter, instead of the usual curved hair. The spine is the same length as the trochanter. Figures 6 and 7 of the front coxa and genitalia respectively may enable the species to be recognised by other workers, though it may prove to be new.

[*Drosophila melanogaster* Meigen.

Three female specimens of this species were obtained from one apple trap at Furuflaten and from one fig and one apple trap at Rosta. The condition of these specimens shows that they must have already been (? dead) in the fruit when it was used as trap-bait, two being in a mashed condition and one in an immature condition with wings still furled. Such intrusions in surveys of this sort must be watched for.]

7. Acknowledgments.

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8. Summary.

(1) Collections of Drosophilidae were made in the Rosta (Rostadal) and Furuflaten (Lyngsdal) areas of north Norway during July and August, 1953. Some of the physical and climatological features of the areas are described.

(2) A total of 2069 specimens was obtained, mostly in traps of fermenting fruit.

(3) Ten species of Drosophilidae were collected: *Drosophila obscura* (1841 specimens, or 89 per cent. of total catch), *D. bifasciata* (67, or 3·2 per cent.), *D. silvestris* (2 specimens), *D. funebris* (62, or 3 per cent.), *D. littoralis* (1 specimen), *D. transversa* (6, or 0·29 per cent.), an unidentified species of *Drosophila* (1 specimen), *Chymomyza costata* (52, or 2·5 per cent.), *Amiota alboguttata* (32, or 1·5 per cent.), and *Cacoxenus argyreator* (1 specimen). There were also four unidentifiable fragments.

(4) The second and third species and the last two have not previously been recorded from within the Arctic Circle, and the unknown *Drosophila* is also probably a new record. Five species are recorded for the first time from Norway, viz., *D. bifasciata*, *D. silvestris*, *D. littoralis*, *A. alboguttata*, and *C. argyreator*.

(5) A sudden increase in numbers was experienced at Rosta in mid-August. The most probable cause of this increase was a rise in temperature inducing a mass emergence.

(6) Observations on the height most favoured in woodland showed that traps at 10 ft. attracted most flies. It is suggested that this type of vertical distribution be called " layer distribution ".

(7) It is likely that very few flies occurred above the tree-line, traps being exposed at sea-level up to 2000 ft. It is suggested that this type of vertical distribution relative to ground level be called " contour distribution ".

(8) No flies were reared, but pale specimens (perhaps recently emerged) of *D. obscura* and *D. bifasciata* occurred at Rosta.

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FIG. 1.—Near Furuflaten, near collecting base. Looking north-west to part of ice-capped Jekkevarre (approximately 6250 ft.). Alder in foreground ; birch and alder on slopes. *D. obscura*, *D. transversa* and *Am. alboguttata* caught here. July, 1953.

FIG. 2.—Near Furuflaten. Well-grown (30 ft.) alder copse by Lyngselv (in background). *D. obscura* and *Am. alboguttata* occurred here. July, 1953.

FIG. 3.—Near Rosta, looking east along Rostadal and showing the dense birch forest, with upper tree limit on slopes. Likkevarre (4850 ft.) on right. *D. obscura*, *D. funebris*, *D. bifasciata* and *Ch. costata* caught in the forest. August, 1953.

FIG. 4.—Rosta, with clearings in the birch forest. Rostafjell (5067 ft.) in background. August, 1953.